FINAL REPORT

UTILIZATION OF NON-CONVENTIONAL SYSTEMS FOR CONVERSION OF BIOMASS TO FOOD COMPONENTS

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I. Summary of Accomplishments

The subject of our study has been the investigation of potential use of micro-algae in yielding useful macronutrients (primarily proteins and lipids) for the CELSS. We have isolated and characterized (amino acid analysis and electrophoretic studies SDS-PAGE and IEF) algal proteins from green algae (Scenedesmus obliquus) grown under controlled conditions. Characterization of algal proteins revealed a high content of essential amino acids leucine, valine, phenylalanine and lysine. The algal lipids showed high content of total unsaturated fatty acids. To optimize the removal of algal lipids and pigments and to minimize protein denaturation, we used supercritical fluid (SCF) extraction using carbon dioxide with and without ethanol as a co-solvent, which resulted in more efficient removal of algal lipids and improved water solubility of protein isolate. Algal proteins were isolated from Synechococcus 6311 and characterized (amino acid analysis and electrophoretic studies).

RNA and DNA contents were determined, and methodology for reduction of nucleic acid content to acceptable levels developed. Lipid extraction procedures using supercritical fluids were tailored to removal of undesirable lipids and pigments.

Initial steps towards preparation of model foods for potential use in CELSS were taken. Our goal was to fabricate food products which contain isolated algal macronutrients such as proteins and lipids and also some components derived from higher plants including wheat flour, soy flour, potato powder (flakes), soy oil and corn syrup.

Large scale preparation of protein isolate from Scenedesmus obliquus

was achieved. Ethanol extraction of lipids and pigments from protein concentrate was completed overnight. The isolate was air dried (at room temperature) and ground to a fine powder. The isolate which had a light olive color was used for incorporation into food products.

The food items prepared were: bran muffins (ingredients: wheat flour, bran, algal protein isolate, milk, eggs, butter, molasses, salt, sugar, baking soda and grated orange rind); chocolate chip cookies (ingredients: wheat flour, algal protein isolate, sugar, brown sugar, butter, eggs, chocolate chips, baking soda and vanilla); Fettuccine (spinach noodles imitation) (ingredients: wheat flour, algal protein isolate, eggs, vegetable oil, water and salt). As a comparison, we also incorporated commercially available spray-dried Spirulina (Earthrise™, The Earthrise Co., Berkeley, CA) into food samples. The amounts of incorporated algal protein isolate for muffins and cookies were 5% of the total flour weight (i.e. 95% wheat flour) and for fettucini we had 5 and 10% isolate. Same percentages were used for commercial spirulina samples. The description of the taste of the control cookies and muffins was "regular" (standard). The panel described the taste of the cookies containing protein isolate as slightly grassy (algal flavor) and the taste of the cookies containing commercial spirulina as a slightly bitter "over processed" flavor. Similar taste descriptions were given to muffins, but the tastes were stated to be stronger in muffins. This is because in cookies the above tastes were masked by the chocolate and vanilla flavors. The greenish color of the cookies and muffins was not found to be objectional. However, the color of the S. obliquus cookies and muffins were lighter than those of commercial spirulina. The texture of all the cookies and muffins were moist and pleasant.

Cooked fettuccine was tasted with and without (plain) cheese sauce.

The taste of the plain control was described as spinachy or slightly grassy. The plain 5% S. obliquus fettuccine had an almost bland taste and the 10% one had a slightly grassy flavor. For commercial spirulina (5%) plain fettuccine an after taste was detected which was stronger as the level of algae increased to 10%. When the panelists had a cheese sauce with the fettuccine the scores were improved. Fettuccine containing 5 and 10% S. obliquus protein isolate were rated very good and no grassy taste could be detected. When commercial spirulina fettuccine (5 and 10%) tasted with the sauce the after taste was still detectable. The color of the fettuccine made from isolate was lighter than that made from commercial spirulina and compared well with the green color of spinach fettuccine (control). The texture of all different fettuccine products were satisfactory.

Sensory tests showed that products prepared from algal isolates were acceptable and superior to those made with commercial algal preparations used in similar concentrations.

II. Bibliography

(All of the reports and reprints listed below were submitted previously to Dr. Robert Mac Elroy, Technical Monitor at NASA Ames)

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